ALGAL COVER AND ITS EFFECT ON REGENERATION AND PUMPING RATES OF SPONGES

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Abstract. In the past ten years, algal cover has increased dramatically in the Discovery Bay reef. Little research has been done on the effects of algal growth on sponges. We examined the amount of algae cover on six different species of sponges and its effects on tissue regeneration and pumping rates on one of the six species. We found that some species exhibit higher algal cover than others. Algal cover is also shown to decrease pumping rates and regeneration of damaged tissue. Because the local algal cover has increased in the past ten years, these results have important implications on competitive interactions among sponges and between sponges and other benthic invertebrates in the Jamaican coral reef community.

INTRODUCTION (WLO)

Sponges, Phylum Porifora, are an important component in coral reef communities. They filter large quantities of water, compete with benthic invertebrates for space, and provide a food source and shelter for many fishes and invertebrates.

Many interactions exist between sponges and corals. Some sponge species contribute to reef building by holding together coral rubble, stabilizing it while coral regenerates and establishes itself. Other sponges are harmful to reefs, burrowing into corals and injuring coral colonies.

In Discovery Bay, Jamaica, several large-scale disturbances over the past 15 years have had a huge impact on the coral reef communities. Before these disturbances, macroalgae cover was less than 5% on the reef except in intertidal zones, damselfish territories, and in water deeper than 25 m (Hughes 1994). Two hurricanes, Allen (1980) and Gilbert (1988), severely damaged the reef, overturning and killing many corals, and made way for successional blooms of algae. Disease wiped out a major herbivore, the sea urchin, *Diadema antillerum*, in 1983. In addition to these catastrophes, overfishing has been a persistent problem in Jamaica since the 1960's and has drastically reduced the abundancy of herbivorous fishes. The declining population of herbivorous fishes and urchins is unable to control the algal crop. Thus macroalgae has proliferated steadily over the past decade, overgrowing coral, and killing many of the adult colonies. The profound effects of algae on corals has been intensively studied and it is known that the coral abundances have decreased since the algal cover increased. However, little research has been done on the effects of algal overgrowth on sponges.

Corals of certain morphological characteristics can tolerate or escape algal encroachment better than others. Branching corals survived the best while mound corals suffered the most from algal overgrowth (Isaacs et al. 1992). We predicted to find a similar pattern of algal growth on sponges of different morphologies.

Algae interferes with the vital functions of corals by overshadowing and blocking light from reaching the photosynthetic zoo-xanthellae. Sponges are not photosynthetic, thus do not require light. Algal growth on sponges may have an affect on necessary functions of the sponge such as food filtration and regeneration. The sponge surface is perforated with many small incurrent ostia pores which draw in water. The beating of the flagella in the collar cells pump the water through the interior while food and oxygen are filtered out. Then the water is expelled through the main excurrent oscula opening. We expected to find that algal growth on sponges interferes with this water flow. This may in turn affect the pumping rate of the sponge.

Lastly, we predicted that algal cover would also slow down regeneration of sponges since inhibited water flow may decrease the nutrient intake in that area.

METHODS (WLO)

We conducted our research on the fore reef of Discovery Bay, Jamaica with SCUBA at depths from 30 to 40 ft near the Long Term Study mooring from 1-9 March 1995. Coral reef buttresses divided by sandy channels show heavy algal cover.

Six abundant sponges were used in our study:

1) Blue-yellow tube sponge (*Verongula ardis*) 2) Yellow tube sponge (*Aplysina fistularis*)
3) Brown lobe sponge
4) Lavendar rope sponge
5) Green rope sponge
6) Charcoal blob sponge

The percentage algal cover was determined along four transects, two east and two west of LTS mooring. We recorded the estimated percent algal cover for every sponge of the six study species that we saw. The sponges were ranked into a percent algal cover class: <1%, 1-5%, 5-15%, 15-25%, or 25-50%. The type of algae (*Dictyota*, *Lobophora*, *Sargassum*, and/or *Halimeda*) was recorded.

Blue-yellow sponges were used in the pumping rates experiment, which were conducted over three nights. Ten sponges with a singular osculum and low algal growth were collected. The sponges were set up in tubs of sea water with a ruler extending from the osculum. Drops of carmin dye were released at the osculum with a pipette, taking care to avoid touching the osculum and causing it to contract. The pumping rate, defined as the elapsed time it took for the red dye to flow 4 cm in the exhalant current from the osculum, was recorded. Twenty replicates were performed with each sponge for each treatment. Each sponge received two treatments, the control, with no algal cover, and the experimental, where it was covered with an algal skirt. The skirts were constructed of *Lobophora* lobes sewn together, and then slipped over the tube. Each night we alternated which treatment was done first to control for slowed pumping rates resulting from decline in sponge condition due to time in captivity. After each trial, the sponge remained undisturbed in flowing sea water for at least two hours to allow it to resume its normal pumping rate before the next treatment began.

Twenty blue-yellow sponges with approximately 15-25% algal growth were selectively chosen for the regeneration experiment. Two holes were bored on each sponge with a .4 cm cork borer. One hole was bored in an area covered with algae while the other hole was bored in a algae free area. Four days later, the holes were measured along the widest diameter to determine if any regeneration had taken place. Observations of healing and tissue growth were recorded.

RESULTS (AVB)

We found that percent algal cover differed significantly among the six species of sponges surveyed ($G=133.59$, $df=20$, $P<0.001$). Blue-yellow sponges had high algal cover , while brown lobe sponges and green rope sponges had low algal cover (Table 1). *Dictyota*, *Lobophora*, *Halimeda* and *Sargassum* accounted for most of the macroalgae cover on the sponges. Mean pumping rate (as defined in methods) was significantly higher when the sample sponges were not covered with algae

TABLE 1. Number of sponges of each species in each of five classes of percent algal cover.

BY=blue-yellow tube	1 = <1% cover
BL=brown lobe	2 = 1-5% cover
LR=lavendar rope	3 = 5-15% cover
GR=green rope	4 = 15-25% cover
YT=yellow tube	5 = 25-50% cover
CB=charcoal blob	

	cover class					
	1	2	3	4	5	TOT
BY	1	15	19	8	16	59
BL	36	17	5	0	2	60
LR	9	12	3	1	0	25
GR	40	25	3	0	0	68
YT	9	16	4	3	0	32
CB	12	13	5	2	1	33
TOT	107	98	39	14	19	277

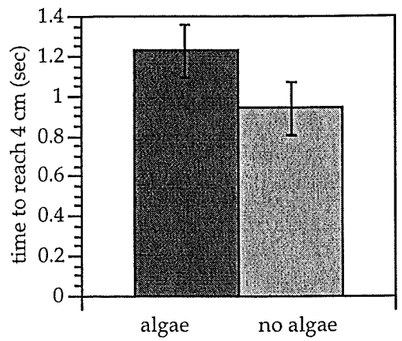

FIG 1. Mean pumping rates (as defined by time to reach 4 cm) of sponges with and without algae cover (bars ± SE).

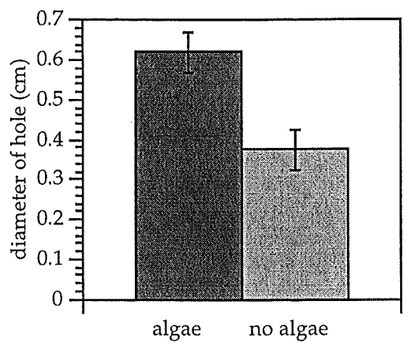

FIG. 2 . Diameter of hole remaining after four days of regeneration time for holes covered by algae and not covered by algae (bars ± SE).

(T=-2.67, df=9, P=0.026; Figure 1). The mean reduction in pumping rate with algae cover was 39 ± 15%. Regeneration was also greater on sponge tissue not covered with algae (T=4.58, df=19, P<0.001; Figure 2). The mean difference between hole size on algae covered and uncovered holes was .26 ± .06 cm.

DISCUSSION (AVB)

Algae appears to affect all six species of sponges examined to some extent. All six species of sponges had individuals that showed at least 5-15% algae cover. Percent cover of algae varied among the six different species. The blue-yellow tube sponges showed high algal cover, while the brown lobe sponge, the charcoal blob sponge, and the rope sponges showed low algal cover. However, our survey is biased towards sponges with lower algae cover, as the sponges with greater algae cover are harder to see.

Factors influencing the extent to which a sponge will be covered by algae include size, growth form and texture. Sponges such as the blue-yellow tube sponge grow low and wide, with a large proportion of their surface area concentrated near the ground where it can be readily overgrown by algae. In contrast, rope sponges branch out tall and thin, and thereby may escape algal overgrowth on all but the lowermost surface.

It is interesting to note that the charcoal blob sponge shares a similar growth form with the blue-yellow tube sponge, yet we did not observe such high percent of algal cover on it. This may be due to the difference in texture of the two sponges. The charcoal blob sponge is smooth, while the surface of the blue-yellow tube sponge is rough with many indentations. It may be easier for algae to adhere to the rough surface than to the smooth surface of the charcoal blob sponge. Similarly, the brown lobe sponge grows relatively close to the substrate, and showed little algal overgrowth. Although yellow tube sponges grow tall like rope sponges, it was found to have intermediate amounts of algal cover. However, it has a rough surface like the blue-yellow tube sponge may be easy for algae to adhere to.

Pumping rates were significantly slower when sponges were covered with algae. Sponges draw water in through their ostia by the beating of cilia, filter nutrients out, and then pump the water out through the osculum. When lobes of algae are against the surface of the sponge, it interferes with the intake of water, and the collar cells must pull water in through the algae. When the water passes through the lobes of algae, important nutrients might also be filtered out before the water reaches the sponge.

Regeneration was also less when the holes were bored under algae than when they were bored into uncovered sponge

tissue. This may be related to the effect of algal cover on the pumping rates. Areas covered by algae may receive fewer nutrients due to the reduced water flow through the ostia and the filtering effect of the algal cover. These covered areas will not receive as many nutrients to invest in tissue regeneration as an area without algal cover that is able to pump in more water.

Although we were unable to measure sponge growth directly, it may also be negatively affected by algal cover. Growth of new tissue depends on many of the same factors as tissue regeneration. Algal cover may decrease nutrient intake to affected areas, especially around the base of the sponge where the algae is growing up from the ground. In low growing sponges , like the blue-yellow tube sponge, algae may inhibit nutrient uptake in areas around the base of the sponge where lateral growth occurs.

Algal growth can have negative effects on sponges. A decrease in tissue regeneration, pumping rates and nutrient uptake, and growth of sponges could seriously reduce the ability of sponges to compete for substrate, one of the most limiting resources for benthic invertebrates. By weakening the sponge, algal overgrowth may alter the outcome of competitive interactions among sponges, between sponges and corals and between sponges and other benthic invertebrates. This may result in a change in both the dynamic s and the composition of the coral reef community.

LITERATURE CITED

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